MATERIALS BUREAU

TECHNICAL REPORT 90-1

EVALUATION OF A MICROSILICA CONCRETE OVERLAY

CONSTRUCTION REPORT

NOVEMBER 1990

M.A.P. CODE 7.42-6-90-1

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
MARIO M. CUOMO, Governor
FRANKLIN E. WHITE, Commissioner

TECHNICAL REPORT 90-1

EVALUATION OF A MICROSILICA CONCRETE OVERLAY
CONSTRUCTION REPORT

Conducted in Conjuncton With
The U.S. Department of Transportation
Federal Highway Administration
Experimental Feature Project Number NY 76-06E

Prepared by

Thomas E. Pericak, P.E.
Civil Engineer II (Materials)

and

Ronald A. Sines, P.E.
Civil Engineer II (Materials)

November, 1990

MATERIALS BUREAU
WAYNE J. BRULE, P.E., DIRECTOR

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
1220 WASHINGTON AVENUE, ALBANY, NY 12232

M.A.P. CODE 7.42-6-90-1

ABSTRACT

Corrosion of plain reinforcing steel in the top reinforcing bar mat of bridge decks has become a major problem across the country where deicing chemicals are used. This has occurred to such a large extent that plain reinforcing bars have been replaced by more corrosion resistant epoxy coated reinforcing bars. However, there exists a significant number of bridge decks which were constructed with plain reinforcement which will need to be rehabilitated to correct corrosion induced distress some time during their service life. The New York State Department of Transportation currently performs this rehabilitation by removing the deteriorated concrete, often times to levels below the top reinforcing bar mat, cleaning the reinforcement where necessary, and placing an overlay of either a High Density Concrete, Latex Modified Concrete, or a Microsilica Concrete. This report details the construction of a Microsilica Concrete overlay. It is only intended to provide details of the construction and post construction inspections. Later reports will detail the long term performance of this structure.

CONTENTS

APPENDICES

I. INTRODUCTION

In 1985 the New York State Department of Transportation installed its first Microsilica Concrete (MSC) overlay in Syracuse, New York. Since that time numerous structures have been overlaid with MSC and this has become an overlay option to High Density Concrete (HDC) and Latex Modified Concrete (LMC).

The benefits of MSC include its low permeability, its ability to be supplied from a concrete batch plant rather than a mobile mixer, and it can be placed and finished with conventional equipment. The low permeability of the Microsilica concrete will help protect the plain reinforcing steel from the corrosive degradation initiated by chloride ion penetration. The ability to be supplied from a concrete batch plant may offer contractors benefits in that mobile mixer units will not have to be rented, calibrated, or maintained. Also, the MSC option allows the concrete batch plants to participate in the overlay market from which they were previously excluded, which results in competitive bid pricing.

II. DESCRIPTION AND LOCATION

The experimental overlaid bridge deck was part of NYSDoT Project Number D500678 which consisted of the rehabilitation of five bridges on I787 in Albany County. The total area of overlay to be placed on this contract was estimated to be 284,640 square feet. The overlay cost was bid at $4.30/SF. Originally the contract was bid to supply HDC but the contractor requested and was approved to substitute MSC.

The structure to be monitored caries I787 south bound over a ramp to the New York Thruway (BIN 1-04966-9). The structure is composed of three simple spans and is approximately 39 feet wide and 188 feet long with the joints placed at a 50° skew. The average annual daily traffic was estimated at 13,300 in 1985.

A map detailing the location of the experimental deck can be found in Appendix A.

III. PREPARATION AND PREPLACEMENT

The reconstruction on this structure was carried out in two stages. Stage I consisted of repairs to the center and third lanes while Stage II consisted of the driving lane and a narrow shoulder.

Prior to removal of the top portion of the existing concrete deck, half cell potential readings were taken, results of which are shown in Appendix B, and a delamination/crack survey performed. The results of the half cell potential survey indicated an even split between high and medium potential areas. There was an insignificant number of low potential areas found. Based on these results, it was decided to remove the entire existing concrete deck to a level 1" below the top bar of the top bar mat.

Concrete removal was accomplished by scarification of the top surface, followed by jack hammering to expose the reinforcing bars. Next, the exposed concrete surface and reinforcing bars were blastcleaned to remove all partially loosened concrete, grease, dirt, concrete mortar and injurious rust. Following this cleaning, a bonding grout was broomed into the prepared surface immediately prior to the placement of the slab reconstruction concrete, a NYSDoT Class D concrete. The Class D was consolidated using internal vibration, and the concrete was then screeded off to approximately 1/2" above the top reinforcing bar mat leaving an intentionally roughened surface. The slab reconstruction concrete was covered with wet burlap and wet cured for 72 hours.

IV. PLACING AND FINISHING THE OVERLAY

The Stage I overlay was placed on August 26, 1989 between approximately, 4:30 AM and 9:00 AM. The Stage II overlay was placed on October 14, 1989 between approximately 9:00 AM and 1:00 PM.

Prior to placement of the MSC, the deck surface was prepared by blastcleaning to remove all laitance and partially loosened chips of concrete.

The MSC was supplied from a central mix plant which resulted in haul times of approximately 10 minutes. Upon arrival at the site, testing was performed on the plastic concrete. These results, along with the ambient conditions during placement, are listed in Appendix C.

Immediately prior to the placement of the MSC, a bonding grout was broomed into the prepared surface of the deck. The MSC was then deposited on the deck using concrete buggies. The finishing machine used for these placements was a Gomaco drum roller. It consists of a vibrating pan followed by a strike off auger and finally a finishing roller. In addition to the vibrating pan, pencil vibrators were also used to help consolidate the concrete. The finishing machine was not operated along the skew of the joints. Therefore, the initial stages of each placement were consolidated by pencil vibrators and finished by hand.

Prior to surface texturing, the finished surface was checked with a ten foot straight edge to ensure the proper final grade was met and that surface irregularities in excess of 1/8" in ten feet were not present. The finished surface was then textured by one pass of an artificial turf drag which had been attached to a bullfloat. Finally, the deck surface was covered with wet burlap, being careful to avoid any folds, bubbles, or dragging of the burlap. At times, the burlap covering was delayed up to forty minutes. The burlap was kept continuously wet for 96 curing hours using soaker hoses. Following curing, the deck was saw cut to provide transverse grooves 1/4" deep, 1/10" wide, and 1-1/2" on center.

The mix designs for the MSC and the bonding grout can be found in Appendix D.

V. POSTCONSTRUCTION INSPECTION

An initial Postconstruction inspection was conducted on August 9, 1990. This inspection consisted of taking half cell potential readings and performing a delamination and crack survey. This inspection was limited to the driving and center lanes due to continued construction in the area.

The half cell potential survey revealed the majority of potentials to be in the 0.26 V to 0.30 V range, which seems to be somewhat high. Initially, the steel will corrode until it forms a passive layer, which later acts to protect the steel. After a short time, the potentials should decrease and stabilize. The delamination survey, conducted by hammer sounding, did not indicate any delaminated areas. The crack survey did identify several cracks of varying severity and some patched areas (placed to correct minor construction deficiencies). A map of the crack and patch locations can be found in Appendix E. As a general observation, it should be noted that the deck is exhibiting minor scaling in some isolated areas which we are attributing to excessive bullfloating of the MSC.

VI. FURTHER EVALUATION

This bridge deck will be monitored biennially for the next several years. During these evaluations, the following information will be obtained:

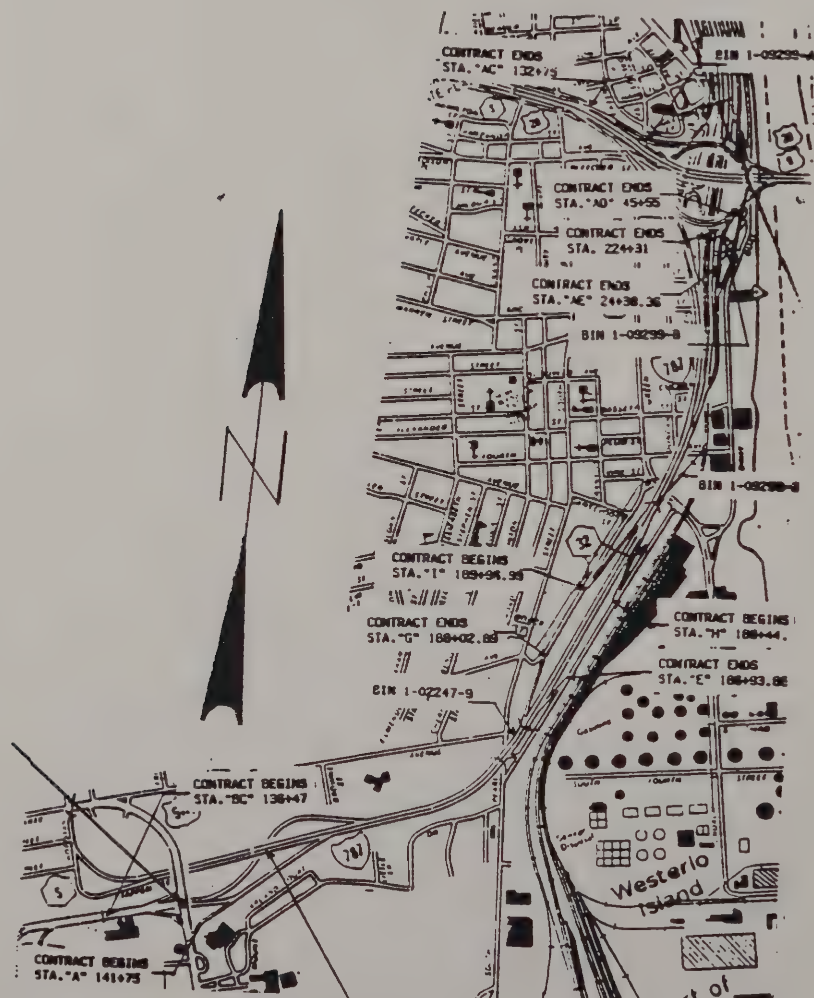
1) Half Cell Potential Data
2) Delamination Survey
3) Crack Survey
4) Chloride Ion Penetration Data

The results of these evaluations will be reported in later Technical Reports which will include data from this deck as well as the other three MSC bridge decks being monitored by the Department.

APPENDIX A

LOCATION MAP FOR BIN 1-04966-9
ON I787 IN ALBANY COUNTY


Structure C


CONTRACT ENDS
STA."AD" 45+55
CONTRACT ENDS
STA. 224+31
BIN 1-09299-B
CONTRACT BEGINS
STA."I" 189+96.99
BIN 1-02247-9
CONTRACT BEGINS
STA."BC" 136+47
CONTRACT BEGINS
STA."A" 141+75
Westerlo
Island
NEW YORK STATE
THRUWAY
EXIT 23
STRUCTURE C
BIN 1-04966-9

APPENDIX B

POTENTIAL DATA FOR BIN 1-04966-9

SPAN ONE

<u>REFERENCE</u>

AREA	RANGE	SYMBOL	FREQUENCY PRECONST	FREQUENCY POSTCONST
LOW POTENTIAL	≤.14V	XXXX	1	0
MEDIUM POTENTIAL	.15V-.34V	0000	54	61
HIGH POTENTIAL	≥.35V	****	39	0

PRECONSTRUCTION POTENTIAL DATA

STAGE I - JULY 1989 STAGE II - SEPTEMBER 1989

```
                                           45   50   55   60   65   70   75   80   85   90   95   100
                                           |    |    |    |    |    |    |    |    |    |    |    |
                                     5 -- 0000 0000 0000 0000 0000 0000 **** **** 0000 **** **** **** -- 5
                                10 --0000 **** 0000 **** **** **** **** 0000 **** **** **** ****-- 10
   SOUTH                        14 --**** 0000 **** 0000 0000 **** 0000 0000 0000 0000 ****-- 14
   ABUTMENT                22 --**** 0000 **** 0000 **** **** **** **** **** ****-- 22
                     17 --**** 0000 0000 **** 0000 0000 0000 0000 0000 **** **** ****-- 17          PIER 1
                12 --**** 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 ****-- 12
            7 --**** 0000 0000 0000 0000 0000 0000 0000 0000 0000 ****-- 7
2 -- **** **** 0000 XXXX 0000 0000 **** 0000 0000 0000 0000 0000 ****-- 2
     |    |    |    |    |    |    |    |    |    |    |    |    |
     5    10   15   20   25   30   35   40   45   50   55   60   65
```

AVERAGE POTENTIAL VALUE = 32.4 STANDARD DEVIATION = 7.30

--DIRECTION OF TRAVEL-->

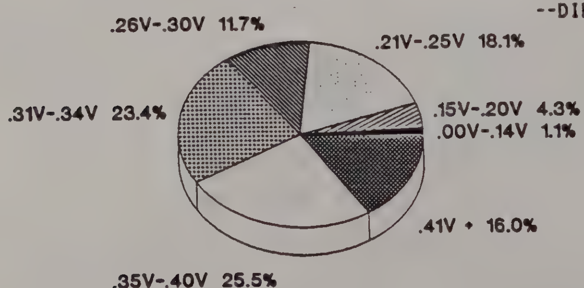
POSTCONSTRUCTION POTENTIAL DATA

August 9, 1990

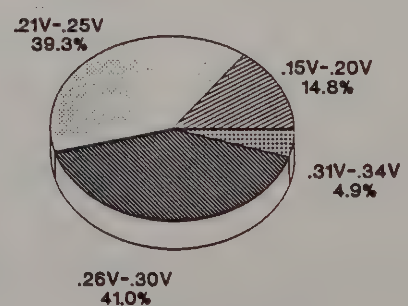
```
                                          45   50   55   60   65   70   75   80   85   90   95   100  105
                                          |    |    |    |    |    |    |    |    |    |    |    |    |
                                    2 --0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000-- 2
  SOUTH                        7 --0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000-- 7
  ABUTMENT                12 --0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 - 12
                     17 --0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000-- 17
                22 --0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000-- 22          PIER 1
           27 --                                                              -- 27
      32 --                                                              -- 32
 37 --                                                              -- 37
      |    |    |    |    |    |    |    |    |    |    |    |    |    |
      10   15   20   25   30   35   40   45   50   55   60   65   70   75
```

AVERAGE POTENTIAL VALUE = 24.4 STANDARD DEVIATION = 3.52

--DIRECTION OF TRAVEL-->



PRECONSTRUCTION



POSTCONSTRUCTION

SPAN TWO

		REFERENCE		
			FREQUENCY	
AREA	RANGE	SYMBOL	PRECONST	POSTCONST
LOW POTENTIAL	≤.14V	XXXX	0	0
MEDIUM POTENTIAL	.15V-.34V	0000	36	73
HIGH POTENTIAL	≥.35V	****	76	1

PRECONSTRUCTION POTENTIAL DATA

STAGE I - JULY 1989   STAGE II - SEPTEMBER 1989

```
                                        45   50   55   60   65   70   75   80   85   90   95   100  105  110
                                         |    |    |    |    |    |    |    |    |    |    |    |    |    |
                                   5 --0000 0000 0000 0000 0000 0000 **** **** **** **** **** **** **** ****--
                                  10 --0000 0000 0000 0000 0000 0000 **** 0000 **** **** **** **** ****-- 10
   PIER 1                   14 --**** **** **** **** **** **** **** 0000 0000 **** **** **** **** **** ****-- 14
                       22 --**** **** **** **** 0000 **** **** **** **** **** **** **** **** **** ****-- 22
                  17 --0000 **** **** **** **** **** **** 0000 0000 0000 0000 **** **** ****-- 17       PIER 2
             12 --0000 0000 **** **** 0000 0000 0000 0000 0000 0000 0000 **** 0000 ****-- 12
         7 --**** **** **** **** **** 0000 **** 0000 **** **** **** **** **** ****-- 7
  --**** **** **** **** **** **** **** 0000 0000 0000 **** **** **** ****-- 2
     |    |    |    |    |    |    |    |    |    |    |    |    |    |
    10   15   20   25   30   35   40   45   50   55   60   65   70   75
```

AVERAGE POTENTIAL VALUE = 36.9   STANDARD DEVIATION = 6.65

--DIRECTION OF TRAVEL-->

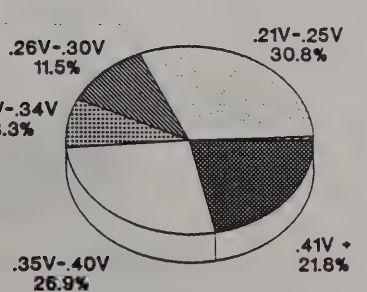
POSTCONSTRUCTION POTENTIAL DATA

August 9, 1990

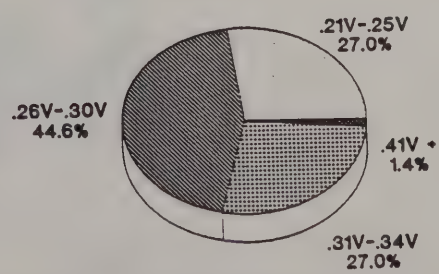
```
                                        45   50   55   60   65   70   75   80   85   90   95   100  105  110
                                         |    |    |    |    |    |    |    |    |    |    |    |    |    |
                                   2 --**** 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000--
                            7 --0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000-- 7
   PIER 1              12 --0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000-- 12
                  17 --0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000-- 17
             22 --0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000-- 22      PIER 2
             27 --                                                                          -- 27
        32 --                                                                          -- 32
  7--                                                                          -- 2
     |    |    |    |    |    |    |    |    |    |    |    |    |    |
    10   15   20   25   30   35   40   45   50   55   60   65   70   75
```

AVERAGE POTENTIAL VALUE = 28.2   STANDARD DEVIATION = 3.56

--DIRECTION OF TRAVEL-->



PRECONSTRUCTION



POSTCONSTRUCTION

SPAN THREE

	REFERENCE		FREQUENCY	
AREA	RANGE	SYMBOL	PRECONST	POSTCONST
LOW POTENTIAL	≤.14V	XXXX	6	0
MEDIUM POTENTIAL	.15V-.34V	0000	46	52
HIGH POTENTIAL	≥.35V	****	31	2

PRECONSTRUCTION POTENTIAL DATA

STAGE I - JULY 1989 STAGE II - SEPTEMBER 1989

```
                                   45   50   55   60   65   70   75   80   85   90
                                    |    |    |    |    |    |    |    |    |    |
                                5 --**** 0000 0000 XXXX 0000 0000 0000 0000 **** 0000-- 5
                           10 --0000 0000 0000 0000 0000 0000 **** 0000 0000 ****-- 10
                       14 --**** **** **** **** **** **** **** **** **** ****-- 14
 PIER 2
                  22 --0000 0000 0000 **** 0000 0000 **** 0000 **** ****-- 22
              17 --0000 0000 **** **** **** **** 0000 0000 **** **** ****-- 17        NORTH
          12 --0000 0000 0000 **** **** XXXX **** 0000 0000 0000-- 12                 ABUTMENT
      7 --**** 0000 0000 0000 XXXX 0000 0000 XXXX XXXX 0000 0000-- 7
  2 --**** 0000 0000 0000 0000 0000 **** 0000 0000 XXXX 0000-- 2
      |    |    |    |    |    |    |    |    |    |    |
      5   10   15   20   25   30   35   40   45   50   55
```

AVERAGE POTENTIAL VALUE = 30.1 STANDARD DEVIATION = 9.98

--DIRECTION OF TRAVEL-->

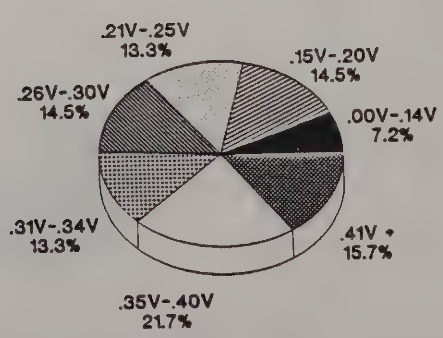
POSTCONSTRUCTION POTENTIAL DATA

August 9, 1990

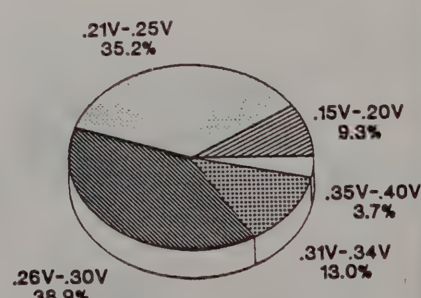
```
                                   45   50   55   60   65   70   75   80   85   90   95
                                    |    |    |    |    |    |    |    |    |    |    |
                                2 --0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000-- 2
                            7 --0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000-- 7
 PIER 2                 12 --0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 ****-- 12
                    17 --0000 0000 0000 0000 0000 0000 0000 0000 **** 0000-- 17
                22 --0000 0000 0000 0000 0000 0000 0000 0000 0000 0000-- 22              NORTH
            27 --                                                   -- 27               ABUTMENT
        32 --                                                   -- 32
    37 --                                                   -- 37
      |    |    |    |    |    |    |    |    |    |    |
      5   10   15   20   25   30   35   40   45   50   55
```

AVERAGE POTENTIAL VALUE = 26.6 STANDARD DEVIATION = 4.26

--DIRECTION OF TRAVEL-->



PRECONSTRUCTION



POSTCONSTRUCTION

APPENDIX C

CONCRETE PLASTIC PROPERTIES TEST DATA AND AMBIENT CONDITION DATA FOR BIN 1-04966-9

PLASTIC PROPERTY TEST RESULTS

Batch #	Batch Size C.Y.	Conc Temp °F	Air %	Slump "	7 Day* Strgth PSI	28 Day* Strgth PSI
		Stage I - 8/26/89				
133	8	80	6.2	7.00	4675	7875
134	8	80	6.3	7.50	3985	6875
135	8	80	6.3	7.50	4555	7945
136	8	80	6.0	6.00	4570	7630
137	8	82	6.1	6.50	4835	7845
138	8	80	6.2	6.25	4450	7565
Average Values		80	6.2	6.75	4510	7625
		Stage II - 10/14/89				
190	9	66	7.2	7.00	3540	6560
191	9	66	5.5	4.25	5175	8875
192	9	66	5.5	6.50	4395	8025
Average Values		66	6.1	6.00	4370	7820

* Represents the average of two cylinders tested

AMBIENT CONDITIONS DURING PLACEMENT

Reading Number	Time AM	Air Temp °F	Relative Humidity %	Wind Speed MPH	Concrete Temp °F	Theoretical Evaporation Rate #/FT²/HR
			Stage I - 8/26/89			
1	4:30	51	94	0	90	.05
2	5:30	50	100	0	80	.04
3	6:30	49	100	0	80	.03
4	7:30	53	100	0	83	.03
5	8:45	60	100	0	80	.01
			Stage II - 10/14/89			
1	9:00	49	74	0	90	.07
2	10:15	56	55	1	66	.04
3	11:10	55	70	0	66	.03
4	12:10	55	70	1	66	.03

APPENDIX D

MIX DESIGNS FOR MICROSILICA CONCRETE
AND BONDING GROUT
FOR BIN 1-04966-9

MICROSILICA CONCRETE

	1 Bag Wgts (Lbs)	1 Cu. Yd. Wgts (Lbs)	1 Cu. Yd. Vol (Cu. Ft.)
Cement	94.0	680	3.459
Water	37.6	272	4.359
Sand (SSD)	197.8	1431	8.891
#1 Cr. Stone	180.4	1305	7.917
Air @ 6.5%	-	-	1.755
Microsilica	11.75	85	0.619

Theoretical Unit Weight = 139.7 lbs/cu. ft.

Note: The 85 lbs. of microsilica is in a slurry which will weigh 170 lbs., 85 lbs. is water and was subtracted from the 272 lbs. of mix water. The 187 lbs. of adjusted mix water was further adjusted for the free moisture content in the fine and coarse aggregates.

This mix design was based on the use of the following materials:

Cement: Atlantic, Ravena, Type I, II

Fine Aggregate: Valente Gravel Inc., Source 1-63F
Test No. 86AF31, S.G. 2.63, ABS. 2.0%,
F.M. 2.79

Coarse Aggregate: Callanan Industries, Inc., Source 1-7R
Test No. 87AR40, S.G. 2.70, ABS. 0.6%

Air Entraining Agent: Daravair M added at 4.0 oz./100 lbs. of cement

High Range Water Reducer: Daracem 100 added at 15 oz./100 lbs. of cement

Microsilica: Force 10,000 (Slurry - 50% solids)

BONDING GROUT

The bonding grout consists of equal parts, by volume, of portland cement and concrete sand, mixed with sufficient water to form a slurry. The consistency of the slurry shall be such that it can be applied with a stiff, synthetic bristle brush or broom to the prepared concrete surfaces in a thin, even coating, approximately 1/8" thick, that will not run or puddle.

APPENDIX E

POST CONSTRUCTION CRACK SURVEY
FOR BIN 1-04966-9

POSTCONSTRUCTION CRACK SURVEY